PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A01M 7/00

A1

(11) International Publication Number: WO 97/16964

(43) International Publication Date: 15 May 1997 (15.05.97)

(21) International Application Number: PCT/DK96/00460

(22) International Filing Date: 6 November 1996 (06.11.96)

(30) Priority Data:
954484 8 November 1995 (08.11.95) NO

(71) Applicant *(for all designated States except US)*: HARDI INTERNATIONAL A/S [DK/DK]; Helgeshøj Allé 38, DK-2630 Taastrup (DK).

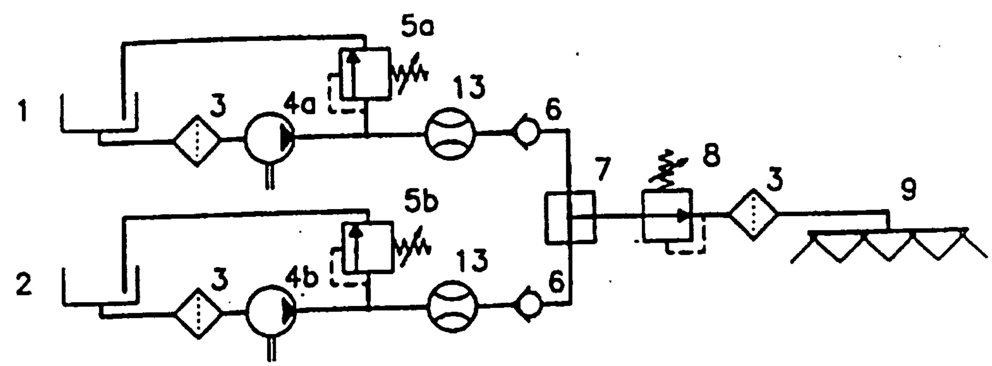
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: BJUGSTAD, Nils [NO/NO]; Granåsbakken 3, N-1410 Kolbotn (NO).

(74) Agent: HOFMAN-BANG & BOUTARD, LEHMANN & REE A/S; Adelgade 15, DK-1304 Copenhagen K (DK).

(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: A SPRAY SYSTEM FOR NEED DOSAGE



(57) Abstract

A method and a device for the dosage of plant protection agent for delivery to a cultivation area using a spray device consisting of at least two tanks (1, 2) having lines which connect the tanks (1, 2) with a mixing chamber and a spray device having nozzles, such that the contents of one tank (1) may be mixed with the contents in the other tank (2), characterized in that one tank (1) contains a plant protection agent in a maximally permissible concentration and the other tank (2) contains a diluent, preferably water.

A spray system for need dosage

The present invention concerns a spray system for need dosage for use in agriculture.

Today, plant protection agents are applied to cultivated land with an even dosage over the entire area. This means that too great amounts of plant protection agents are applied to some areas, while others receive a too low concentration.

Great variation may occur between and within the shifts at a farm when it comes to state of culture, yield of crop and topographical conditions. Crop variations of 40% have been recorded with the same strain and cultivation technique during tests on sloping ground.

Today, the same dosage of plant protection agents is generally used on the entire field. The consumption of plant protection agents becomes greater than necessary. Research results suggest that the consumption of plant protection agents may be reduced by up to 50% with variable dosage, i.e. by using need dosage.

New techniques for regulating delivery and accurate localization permit adjustment for variations in the field. With such an optimum spreading of plant protection agents, the composition and dosage may vary during travel according to the real needs in the field. Further, the drift may be kept at minimal level. Where desirable, the spray quality may be varied without affecting the dosage. Variations in travel sp d will have no influence on the dosage.

Of the annual plant protection agent consumption in Norway of about 1,000 tons of active substance, about 90% is spread with the 20 - 25,000 field sprayers which are available. About 80% of the plant protection agents is herbicides. Traditionally, the entire field is treated with the same dose. This is done although the need should be adapted locally in the field according to the type of harmful organisms (weed, fungus, insect), according to the amount of harmful organisms and growth stage. Further, the dose should be adapted to prevailing spray conditions (temperature, air humidity, wind, etc.). This means that the dose should be varied during spraying, adapted to the biological needs and spray conditions without impairing the spray effect. Also, the need varies much within the individual field. The weed flora is stronger along the edges of the field because of weed seeds from weeds outside the field in ditch edges and the like. The same applies where the cultivated plants do not compete so well with the weed, e.g. on water-logged soil, depressions and boggy soil. The plant protection need is smaller on hill tops, and where the presence of weed is smaller. The need for plant protection agents varies with different local variations of weed in the field, such as e.g. density, fertility, type and number. For example, it is very unfortunate to spray with growth regulating chemicals on grain on hill tops where the soil is dry during almost the entire growth season and results in reduced growth.

The drift, which takes place particular with wind and evaporation, is frequently a problem. Drift-reducing agents may be added to spray liquids, but this is not done because th y involve further costs, and because the consumption becomes excessively great when the same dose must be us d over the entir field, even though the drift is just locally a problem.

It is recommended in Norway that the fields should not be sprayed when the wind is stronger than 3 m/s, at worst never over 5 m/s. The alternative is to lower the spray boom, but this results in poor liquid distribution. To reduce the pressure is not a good solution either, as it affects the dosage. With the technology of today, the travel speed must be kept approximately constant in order not to change the drop picture or pattern. Cleaning of equipment results in pollution of the environment and of the ground water. The working environment in the handling of the agents is not good enough at present, since the surroundings tend to be easily soiled when the sprayers are filled, emptied and cleaned.

In traditional spray equipment using water and preparation in the same tank, the dosage can just be varied to a minor extent, and this is done by changing the working pressure (the nozzle pressure). Changes in pressure have a great impact on the drop size. It is agreed internationally that the pressure must not vary more than +/- 25%, which corresponds to an about +/- 12% change in liquid flow. There is a need for reasonable equipment with a good operational reliability where the active preparation may be added from a separate container to the water flow during spraying, and where the dosage can be varied in a simple manner without changing the drop picture. Active use of control parameters for the spraying is not used very much, e.g. travel speed, wind meter and weed sensor. Some of these parameters will be simple to use, others are more complicated. The drop size should be adapted to the harmful organisms and varying spray conditions. For example, larger drops may be used, independent of dosage changes, where the risk of drift is great.

Economically and environmentally, there is a strong need for a more correct us and utilization of plant protec-

tion agents. The nvironmental authorities and public opinion make ever stricter demands on the spray methods today. Warning service for spray time against diseases has been introduced. The actual preparations have been developed such that they are more active and have less negative environmental impacts. The actual spreading and formation of drops using hydraulic nozzles on ordinary field sprayers are a simple, reasonable and effective method which will be dominating also in the years to come. What is missing, on the other hand, is a more flexible and need-adapted utilization of the spray method such that the consumption of agents may be reduced considerably.

Several countries have realized the advantages of using spray equipment with need control. Consequently, intensive research is being carried out in many countries regarding development of need-controlled dosage equipment. The systems which are being tested or are commercially available are based on a tank containing pure water, while one or more other smaller tanks contain one or more plant protection preparations in a pure concentrate. As the dosage of preparation in agriculture is generally from 2 to 500 g (ml) per daa (20 to 5000 g (ml) per ha), this means that from the preparation tanks:

- very small amounts are to be discharged,
- different amounts are to be discharged for different preparations used,
- the properties of the preparations have a great influence (volatility, miscibility, foaming, etc.)
- mixing is impeded, as the concentration proportion between the liquids in the two tanks is very high; as much as 0 to 100% (in the system of the present invention just 0 to about 1%),
- cleaning of th dosage unit is difficult,

- regulation of the dose will easily b inaccurate and incorrect dosage may occur,
- the operational reliability is poor,
- the dosage unit is very expensive.

In addition, the control to be performed by the user must be carried out using the preparation, which is unfortunate in terms of the working environment and takes a great deal of time. The calibration must frequently be performed, since the regulation of the dose can easily be incorrect and change undesirably over time.

As a result of these drawbacks, the systems commercially available today have not been successful in practice. Examples of systems and patents where active preparation is present in concentrated form in one tank and water in another, and where said drawbacks can easily occur, include:

US Patent No. 4 925 096, European Patent No. 0 201 981, Agri Futura Dose 2000, Mid-West Technology CCI-2000, Vicon Injection System, Direct Injection Closed System at the Silsoe Research Institute and MSR Ciba Geigy Agro inject.

In all these systems, the preparation is present in a concentrated form in one tank, while pure water is contained in another. This means that with the concentrations at which the plant protection agent is to be mixed with water, just a slight incorrect dosage of the concentrate may result in great differences. This may be caused by measurement errors, deposits in ducts or conduits or the properties of the plant protection agent.
The present invention aims at mixing finished spray liquid in the usual manner in a tank in a concentration which corr sponds to normal dosage at e.g. maximum travel

speed. This corresponds to maximum dosage equal to 100%. Water is fed in a variable amount from another tank, which is filled with pure water, to the mixing chamber, when it is desired to reduce the dose and/or the travel speed changes and it is desirable to keep the dose constant. Since the liquid amount out through the nozzles is constant in order not to affect the drop picture, this means that the liquid amount from the first tank must simultaneously be reduced in the opposite proportion.

This provides the following advantages:

- The dosage may be changed without changing the liquid amount fed to the spray boom, i.e. the drop picture/spray quality are maintained (like for other spray equipment with need control).

- The dose is the same even if the travel speed varies (like for other equipment with need control).

- The drop picture may be changed without the dose being changed (like for other equipment with need control).

The spray system for need control according to the present invention additionally provides the following advantages:

- Low concentration difference between plant protection agent and water simplifies and ensures a better, safer and quicker mixing of the two liquids.

- The control by the user is quick and simple and can be perform d accurately using simply pur water in both tanks.

- The dosage unit will be extremely reasonable and operationally reliable because of the following circumstances:
  - only pure water is to be added additionally to a greater or smaller degree, i.e. always the same liquid properties and unharmful liquid,
  - the dosage accuracy is improved, since large water amounts have to be added to regulate the dose. For example, a water amount equal to 10 l/min in case of normal spraying must be added to halve the dose, while with addition of pure preparation, it may be matter of a preparation amount which is 40 to 10 000 times smaller. The latter makes metering of correct dose much more complicated and easily results in incorrect dosage when using a concentrated preparation,
  - great security, since it is impossible to overdose above 100%, which can easily happen when addinng concentrated plant protection agent (such overdosage is prohibited),
  - may be used for powder-formulated preparations.

- Also the water tank has many advantages, such as:
  - cleaning of spray tank (will presumably be required in new spray equipment in ISO and CEN). Here, pure water is pumped from water tank 2 into tank 1 to a washing nozzle which flushes the tank internally. Pure water is also flushed through spray boom and nozzles. The flushing water is sprayed on the crop which is treated.
  - water accessible for hand washing (requirement in Norway, Sweden and Germany).

- Reasonable and operationally reliable spray equipm nt for need control.

The invention will be explained more fully below by means of five figures, which show different ways of regulating the supply of plant protection agents and water.

In the simplest model, which is shown in figure 1, the operating pressure is first regulated in the nozzles on spray boom 9 by control of a pressure reduction valve 8, which is positioned after the mixing chamber 7. The pressure reduction valve provides a constant pressure to the nozzles. The tank 1 is filled with plant protection agent diluted to the maximally permissible concentration, while the tank 2 is filled with pure water.

The pressure at the pressure restriction valve 5a must be set slightly higher than the pressure at the pressure reduction valve 8. The difference depends somewhat on the sensitivity of the pressure reduction valve, pressure loss in hoses and desired pressure at the nozzles, but is just set once before spraying is begun.

If the pressure restriction valve 5b is throttled, the pressure increases somewhat in front of the pressure reduction valve 8. As a result, the pressure restriction valve 5a automatically opens correspondingly. Increased water supply from the tank 2 results in reduced supply of liquid from the tank 1. The system also works conversely. If the valve 5b opens, the pressure drops somewhat, and the valve 5a automatically closes correspondingly. This provides a system in which the supply of liquid is inversely proportional to the supply of water. The spray picture, drop size, operating pressure and liquid amount out through the nozzles 9 remain the same. On the other hand, the concentration of plant protection ag nt in the liquid changes in a controll d manner, so that the dose is adapt d to the spray conditions, as desired. Incorpo-

rated non-return valves 6 protect against backflow of undesired liquid to the tanks.

Figure II is identical with figure I, but additionally incorporates a velocity meter 10. Signals from the velocity meter 10 and the volume flow meters 13a and 13b are received in a control box 12, which regulates the dose by operating the pressure restriction valve 11. The pressure restriction valve is driven e.g. by an electric motor such that the dose continues to be independent of the travel speed. The water supply is changed in inverse proportion to the travel speed, which means that the plant protection agent amount is changed in proportion to the travel speed, as desired.

Figures I and II have simple solutions to keep the pressure constant, while the dose is changed. The equipment may be adapted in a simple manner to standard pump types on existing field sprayers. The mixing chamber 7 is positioned near the nozzles 9 to reduce the reaction time from when dose regulation takes place until desired concentration in the liquid spray after the nozzles is achieved. The liquid flow to the nozzles is adapted such that the change in concentration takes place simultaneously in all the nozzles to the greatest extent possible.

In figure III, signals from the velocity meter 10 and the volume flow meters 13a and 13b are received in the control box 12 like in figure II, such that the dose will be the same irrespective of the travel speed.

The control box 12 may also be constructed such that the drop picture may be changed without the dosage of the plant protection agent being changed. For example, when the wind is rising, the drop size may b increased (the pressure is reduced) so that the d position increases and

the drift is reduced. This takes place in that 100% dosage is set with supply of spray liquid just from the tank 1 at the highest predicted velocity and lowest operating pressure at the nozzles (1.0 bar). The pressure is reduced by reducing the water supply from the tank 2, while the liquid supply from the tank 1 is the same so that the dose is constant. The pressure at the nozzles decreases and the drop size increases. Conversely, the drop size is reduced by increasing the water supply from the tank 2. A similar system may also be incorporated in figure II.

The control box 12 also regulates the liquid flows from the pumps 4a and 4b so that the dose is adapted to the biological needs. This may be done e.g. in that the pressure restriction valve 11a is always regulated in inverse proportion to the pressure restriction valve 11b, which means that the liquid amount to the spray boom 9 is constant. The spray quality remains the same. The pressure restriction valves are regulated e.g. by means of electric motors. The liquid is mixed well in the mixing chamber 7 before it reaches the nozzles on the spray boom 9. The pressure reduction valve 8 in figures I and II is not necessary here.

In figure IV the signals are received in the control box 12 similar to the system in figure III. On the other hand, liquid from the tank 1 and the tank 2 is conveyed forwardly to the nozzles where they are mixed in a small prechamber 15. This minimizes the reaction time from desired dose regulation to completed dose regulation. As the concentration difference between the spray liquid from the tank 1 and the water from tank 2 is small compared with syst ms using th preparation in concentrat d form, the liquids are simply mix d in one or more mixing chamb rs, e.g. a small mixing chamber positioned in front of each nozzle 15.

Both in figure III and in figure IV, the liquid amount may alternatively be regulated directly e.g. by using adjustable pumps or by changing the number of revolutions of the pumps.

Figure V shows a more detailed and further developed system from figure III. Here, also a directional valve 14 is shown. When water is passed from the tank 2 to one or more washing nozzles in the tank 1, the sprayer is cleaned internally in a simple manner in the field. Flushing water is pumped through i.a. the pump 4a, the valve 11a and out through the nozzles on the spray boom 9.

The spray apparatus with need control of the present invention may be provided with additional equipment. Several liquid volume meters, e.g., may be incorporated for direct reading of liquid flow. Pressure sensors may be incorporated in the existing system.

The system may be extended with several tanks for use of several agents. A third tank may be filled with e.g. a drift-reducing substance which may be injected when desired. Here, a great dosage accuracy is not required, and such substance may be used when needed (drift likely).

A chemical filler device with a graded scale should be mounted for simple and safe filling and subsequent flushing of both liquid and powder-formulated preparations.

Level sensors may be incorporated in the liquid tanks and thus indicat the remaining volum and amount of consumed liquid at any time.

A computer may be incorporated for calculation of consumption, sprayed area, dosage, automatic storage of liquid and preparation consumption on data cards and for optional connection to GPC (Global Position System).

Regulation of the dose may take place steplessly or in several steps manually, but may also be performed automatically, based on sensors for harmful organisms, previous experience, data cards, etc.

The possibilities of regulating dose according to local needs as well as constant dose independent of the travel speed are combined in figures II, III, IV as well as V.

The use of the system of the invention allows effective, need-dosed spraying of an agricultural area. It results in a more environmentally sensible use of plant protection agents and chemicals, and it enables differentiation of the added amount of plant protection agent.

Patent Claims:

1. A method of dosing plant protection agent for delivery to a cultivation area using a spray device comprising at least two tanks (1, 2) with lines connecting the tanks (1, 2) with a mixing chamber and a spray device having nozzles, such that the contents of one tank (1) may be mixed with the contents of the other tank (2), characterized in that one tank (1) contains a plant protection agent in a maximally permissible concentration, and the other tank (2) contains a diluent, preferably water.

2. A method according to claim 1, characterized in that the amount and the dosage of the contents from each tank are regulated such that the drop picture and the liquid amount discharged from the nozzles to the spray device are constant, and that the amount of plant protection agent applied per unit of area is constant.

3. A method according to claims 1-2, characterized in that the dosage proportion is recorded by means of measuring and regulating equipment which, by means of valves and/or pumps, regulates the liquid amount which is supplied to the nozzles (9) of the spray device.

4. A method according to one or more of the preceding claims, characterized in that the mixing of the contents from the two tanks (1, 2) is performed immediately before the nozzles (9) of the spray device.

5. A device for the dosage of plant protection ag nt for delivery to a cultivation area, comprising at least two tanks (1, 2) having lines which lead to a mixing chamber

and a spray device having nozzles (9), c h a r a c t e r i z e d in that the mixing chamber (15) is positioned immediately before the nozzles (9).

6. A device according to claim 5, c h a r a c t e r i z e d in that the device additionally comprises metering and regulating equipment which, by means of valves and/or pumps, regulates the liquid amount supplied to the nozzles.

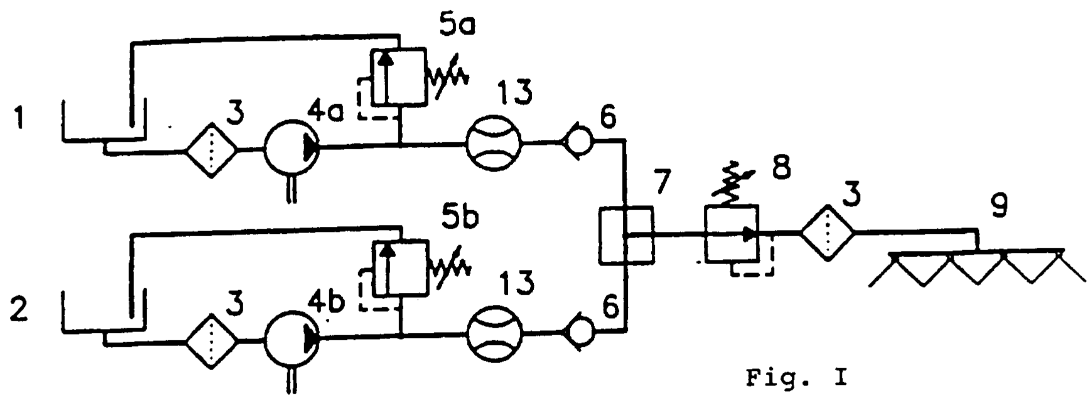


Fig. I

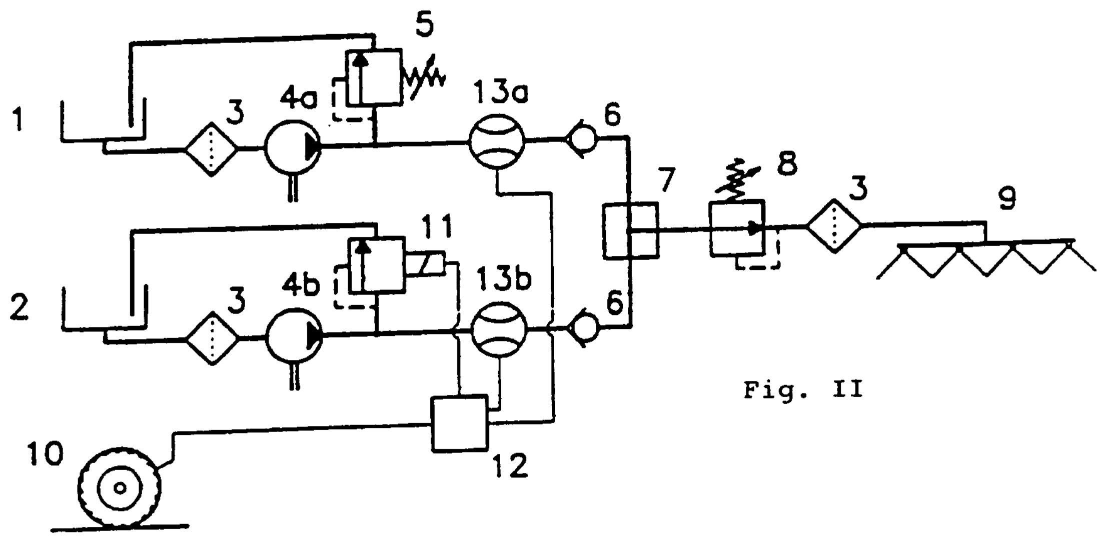


Fig. II

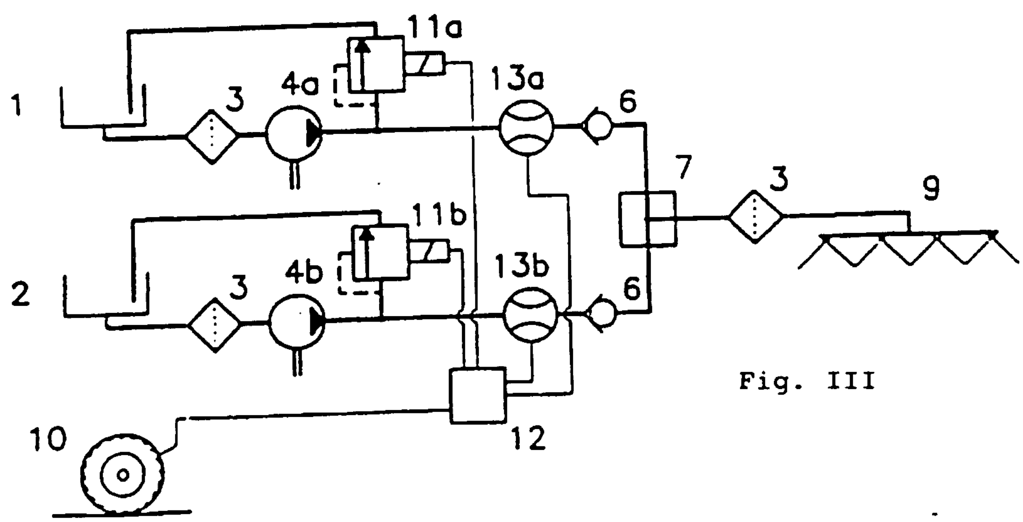


Fig. III

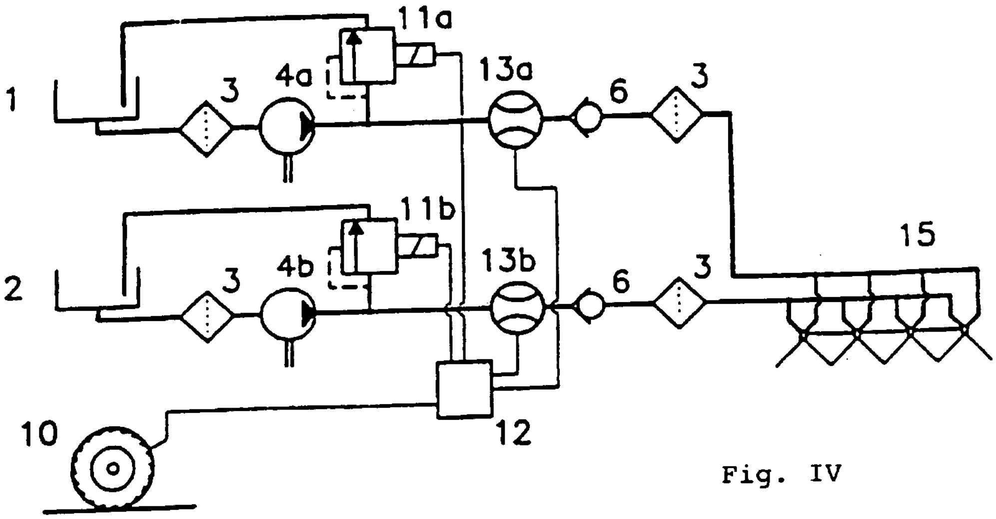

11a
1
3
4a
13a
6
3
11b
15
2
3
4b
13b
6
3
10
12

Fig. IV

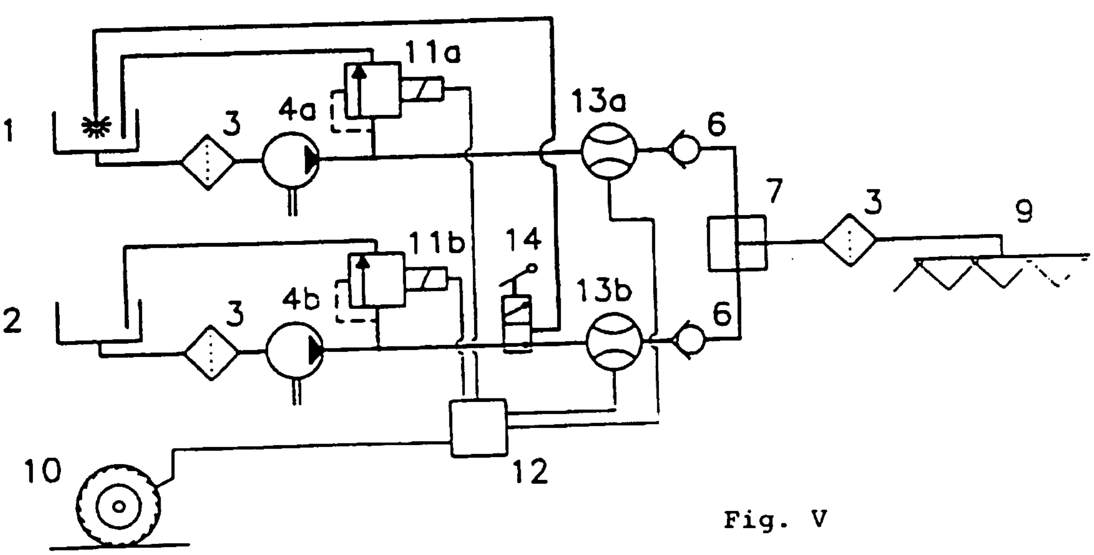

11a
1
3
4a
13a
6
7
3
9
11b
14
2
3
4b
13b
6
10
12

Fig. V

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00460

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A01M 7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0323205 A1 (NOMIX MANUFACTURING COMPANY LIMITED), 5 July 1989 (05.07.89), figure 1, claims 1-10, abstract --	1-6
X	EP 0385926 A1 (CIBA-GEIGY AG), 5 Sept 1990 (05.09.90), figure 2, claims 1-13, abstract --	1-6
X	EP 0527027 A1 (HUNTING ENGINEERING LIMITED), 10 February 1993 (10.02.93), figure 1, claims 1-4, abstract --	1-6

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" erlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 1997	25 -02- 1997
Name and mailing address of the ISA/ Swedish Patent Offic Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Thomas Avasalu Telephone No. +46 8 782 25 00

2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00460

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SE 464607 B (AGRI FUTURA AB), 27 May 1991 (27.05.91), figure 1, claims 1-7, abstract --	1-6
X	FI 61985 B (EINO HAKALA), 30 July 1982 (30.07.82), figure 1, claims 1-2 --	1-6
A	GB 2129663 A (CIBA-GEIGY AG), 23 May 1984 (23.05.84) --	1-6
A	SE 460395 B (BENGT SAMUELSSON), 9 October 1989 (09.10.89) --	1-6
A	SE 467083 B (KENNETH ALNESS), 25 May 1992 (25.05.92) -- --------	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/96

International application No.
PCT/DK 96/00460

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0323205	05/07/89	AU-A- 2754088	06/07/89
		CA-A- 1316506	20/04/93
		DE-A- 3879446	22/04/93
		GB-A,B,C 2214164	31/08/89
		JP-A- 1215367	29/08/89
		JP-B- 6079692	12/10/94
		PT-B- 89348	30/11/93
		US-A- 4925096	15/05/90
EP-A1- 0385926	05/09/90	SE-T3- 0385926	
		AU-B- 627837	03/09/92
		AU-A- 4978990	23/08/90
		CA-A- 2010010	16/08/90
		DE-A,C- 3904759	23/08/90
		JP-A- 2253871	12/10/90
		SU-A- 1809750	15/04/93
		US-A- 5314120	24/05/94
EP-A1- 0527027	10/02/93	GB-A- 2258413	10/02/93
SE-B- 464607	27/05/91	AU-A- 1397988	26/09/88
		DE-D- 3886208	00/00/00
		EP-A,B- 0347421	27/12/89
		SE-A- 8700893	05/09/88
		US-A- 5014914	14/05/91
		WO-A- 8806404	07/09/88
FI-B- 61985	30/07/82	NONE	
GB-A- 2129663	23/05/84	NONE	
SE-B- 460395	09/10/89	AU-A- 3420989	24/11/89
		SE-D- 8801429	00/00/00
		WO-A- 8910050	02/11/89
SE-B- 467083	25/05/92	SE-A- 9002150	16/12/91